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GENOTYPE DEPENDENT VARIATIONS OF SWEET POTATO IN PHOTOSYNTHETIC CHARACTERISTICS

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ABSTRACT

Sweet potato (Ipomoea batatas (L.) Lam.) belonging to the family Convolvulaceae is an herbaceous dicot, widely grown throughout the tropics and warm temperate regions of the world. Presently, genotype dependent variations of sweet potato genotypes in photosynthetic characters were carried out. The stomatal conductance (g_s) and stomatal resistance (r_s) were found to be varied among the genotypes. Decrease in stomatal conductance and increase in stomatal resistance was noticed at a time in all the genotypes. High photosynthetic rate and transpiration rate obtained in Sree-Bhadra were due to high stomatal conductance. Low photosynthetic rate and transpiration rate was obtained in 96-4 that was due to low stomatal conductance and high stomatal resistance. Photosynthetic rate and transpiration rate were found to be varied among the genotypes. An increase in stomatal conductance increases transpiration rate and photosynthetic rate in the sweet potato genotypes. The differences in photosynthetic rate and transpiration rate attributed to the difference in storage root yield.

KEYWORDS: Photosynthetic Rate, Stomatal Conductance, Stomatal Resistance, Transpiration Rate & Genotypes

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INTRODUCTION

Photosynthesis in sweet potato leaves follows the C_3pathway Kays [1]. The photosynthetic rate and the leaf area can be regarded as the “source potential” while the number of storage roots and the mean storage root weight can be regarded as the “sink capacity. The response via photosynthetic rate, transpiration, stomatal conductance and stomatal resistance in the leaves of plant species are controlled by the interaction of atmospheric factors and plant factors, in addition to soil moisture status. The source potential as well as sink capacity varies widely among sweet potato cultivars Hahn [2]. Presently, a study was conducted to find out the genotype dependent variations in sweet potato regarding photosynthetic characters and yield characters.

RESEARCH METHODOLOGY

The experimental plants were selected from the local genotypes, released varieties and open pollinated progenies of sweet potato which are superior genotypes. The genotypes selected for the present study are 94-57, Sree-Bhadra, Sree Rethna, KV-4, 91-7, 95-1, 94-86, 96-4, Kanjangad Local and A-144. Sree Rethna and Sree Bhadra are released genotypes from CTCRI, Trivandrum. Kanjangad local is the local genotype and the rest are open pollinated progenies.

On the 60th day after planting (DAP), photosynthetic rate and related parameters was recorded using LCA-4 portable CO_2analyser ADC, U. K, from randomly selected leaves of each genotype. The photosynthetic efficiency parameters viz., photosynthetic active radiation (PAR), atmospheric CO_2 concentration (Cref), sub

stomatal CO_2 concentration (Ci), air temperature (Tch), leaf temperature (T leaf), stomatal conductance (g_s), stomatal resistance (r_s), photosynthetic rate (A) and transpiration rate (E) were recorded.

RESULTS AND DISCUSSIONS

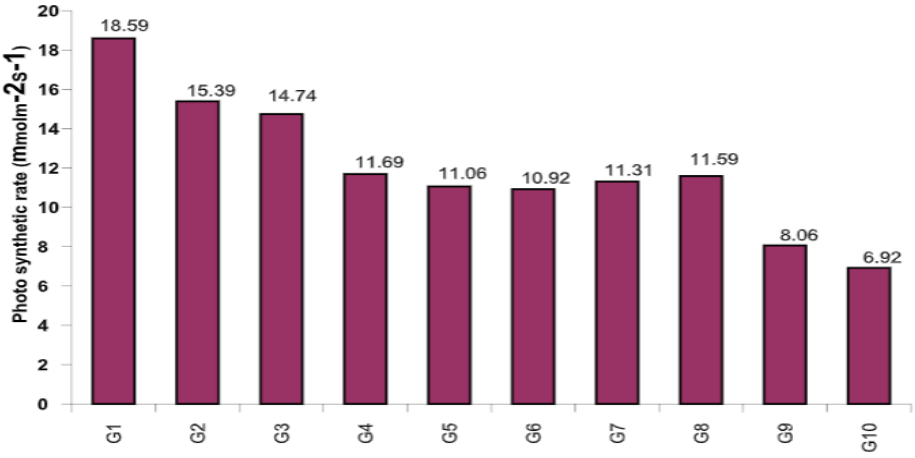
The photosynthetic active radiation (PAR) on the leaf surface varied between 1290 µ mol m^{-2} s^{-1} to 1545 µ mol m^{-2} s^{-1} and atmospheric CO_2 concentration (Cref) varied between 364.2 µ mol $mol^{-1}$to 383.9 µ mol mol^{-1} during the measurement of photosynthetic characteristics of the ten genotypes. The air temperature (T_{ch}) varied from 30.2^{0}C to 34.6^{0}C during the time of measurement. Substomatal CO_2 concentration (C_i) ranged from 163.5 µ mol mol^{-1} to 266.9 µmol mol^{-1}. Maximum C_i was observed in the genotype 94-86 and minimum in 95 –1. The leaf temperature (T_{leaf}) varied from 28.06^{0}C to 34.88^{0}C (Table 1)

Table 1: Photosynthetic Characteristics of the Ten Different Genotypes of Sweet Potato

Genotype	PAR on leaf surface µmol m^{-2} s^{-1}	Cref µmol mol^{-1}	Ci µmol mol^{-1}	Tch ^{0}c	T leaf ^{0}c	g_s mol m^{-2} s^{-1}	r_s m^2 s mol^{-1}	A µmol m^{-2} s^{-1}	E Mol m^{-2} s^{-1}
SreeBhadra	1483	364.2	216.5	30.5	30.67	0.40	2.65	18.59	6.71
SreeRethna	1290	365.4	189.9	32.6	33.04	0.22	5.98	15.39	3.92
94 – 57	1334	367.4	183.2	33.9	34.24	0.28	6.38	14.74	4.59
91 – 7	1381	376.5	174.9	33.6	34.49	0.15	7.34	11.69	4.52
KV – 4	1341	374.6	184.3	33.3	33.43	0.17	6.49	11.06	4.72
95 – 1	1542	383.9	163.5	33.2	33.48	0.18	11.35	10.92	4.06
Kanjangad local	1545	367.7	183.7	32.7	32.17	0.14	5.45	11.31	4
A – 144	1423	376.6	187.1	34.4	34.88	0.19	6.78	11.59	2.34
94 – 86	1445	366.9	266.9	30.2	28.06	0.18	5.54	8.06	3.39
96 – 4	1476	366.6	220.4	34.6	34.27	0.09	11.62	6.92	2.39

Note:

PAR – Photosynthetic radiation
Cref – Atmospheric CO_2concentration
C_i– SubstomatalCO_2 concentration
T_{ch} – Air temperature
T_{leaf} – Leaf temperature
g_s – Stomatal conductance
r_s – Stomatal resistance
A – Photosynthetic rate
E – Transpiration rate



G1 – SreeBhadra
G2 - SreeRethna
G3 - 94-57
G4- 91-7
G5- KV-4
G6- 95-1
G7- Kanjangad local
G8- A-144
G9- 94-86
G10 - 96-4

Figure 1: Photosynthetic Rate of the Ten Genotypes of Sweet Potato.

Studies on the physiology of photosynthesis in sweet potato are very scanty, albeit reports of a similarity to the cycle in C_3 plants Hahn and Hozyo [3] Kays [1]. The photosynthetic active radiation (PAR) or solar irradiance on leaf surface varied between 1290-1545 µ mol m^{-2} s^{-1} at the particular time of measurement, measurement of photosynthetic characteristics of sweet potato genotypes and at that time atmospheric CO_2 concentration (Cref) varied between 364.2 – 383.9 µ mol mol^{-1}. It was noticed that the PAR remained higher than the requirement for saturating photosynthesis in sweet potato leaves. In sweet potato leaves, the photosynthetic rate has been reported to saturate at an irradiance of 600-900 µ mol m^{-2} s^{-1} Ravi and Saravanan [4]. The air temperature (Tch) varied from 30.2 – 34.6^{0}C at the time of measurement. Maximum photosynthetic rate occurs at air temperature greater than 25-34^{0}C Hozyo [5]. Substomatal CO_2 conc. (Ci) varied among the genotypes, with Sree Bhadra, 94-86 and 96-4 showing high substomatal CO_2 concentration, 95-1 low and the remaining genotypes medium concentrations.

The photosynthetic rate varied widely among the ten genotypes (Fig. 1). Maximum photosynthetic rate (A) was observed in Sree Bhadra (18.59 µ mol m^{-2} s^{-1}), which was on par with Sree Rethna (15.39). The lowest photosynthetic rate was observed in the genotype 96-4 (6.92 µ mol m^{-2} s^{-1}), which was on par with 94 – 86 (8.06). The photosynthetic rates in the genotypes Sree Bhadra, Sree Rethna and 94–57 varied from 18.59 to 14.74. 'A' value ranging from 11.06 to 11.69 was observed in the varieties KV – 4, Kanjagad local, A – 144 and 91 – 7. The genotypes 95 – 1, 94 – 86 and 96 – 4 showed photosynthetic rates of 10.92, 8.06 and 6.92, respectively (Table 1, Fig.1).

The photosynthetic rate varied widely among the ten genotypes. Maximum photosynthetic rate (A) was observed in Sree Bhadra (18.59 µ mol m^{-2} s^{-1}), which was on par with Sree Rethna (15.39). The photosynthetic rates in the genotypes Sree Bhadra, Sree Rethna and 94–57 varied from 18.59 to 14.74. The transpiration rate (E) of the genotypes varied from 2.39 to 6.71 mol m^{-2} s^{-1}, with Sree Bhadra showing the maximum value (6.71 mol m^{-2} s^{-1}). Photosynthetic rate (A) was found to vary from 6.92 to 18.59 µ mol m^{-2} s^{-1} among the genotypes. A variation from 5.1 to 22.3 µ mol m^{-2} s^{-1} during day time and 13.2 – 22.3 µ mol m^{-2} s^{-1} during mid-day hours was reported by Ravi [6]. The photosynthetic rate of individual leaves has been observed to vary from 12 – 39 mg CO2 d m^{-2} h^{-1} among the cultivars of sweet potato Bhagsari and Ashley [7]. Varietal differences in photosynthetic rate were also reported by Thorne [8] in Barley. Here, the transpiration rate was found to vary from 2.39 - 6.71 mol m^{-2} s^{-1}. Ravi [6] has estimated the transpiration rate of sweet potato cultivars to vary from 1.8 – 7.5 mol m^{-2} s^{-1} during the day period and from 3.9 – 6.9 during 10.00–15.00 hours. In the present study, the transpiration rate varied from 2.39 to 6.71 among the ten genotypes.

The stomatal conductance (g_s) and stomatal resistance (r_s) varied greatly among the genotypes. It was noticed that although the stomatal conductance of Sree Bhadra, Sree Rethna, KV-4, 91-7 and 96-4 decreased from 0.40-0.09 mol m^{-2} s^{-1}, the stomatal resistance increased from 2.65 to 11.62 m^2 s mol^{-1}. Ravi [6] had also noticed a decrease in stomatal conductance and increase in stomatal resistance in three varieties of sweet potato viz., Sree Bhadra, Kanjangad local and S-108.

The stomatal conductance of genotypes 94-57, A-144 and 95-1 decreased from 0.28 to 0.18 mol m^{-2} s^{-1}, but their stomatal resistance increased from 6.38 to 11.35 m^2 s mol^{-1}. The stomatal conductance of KV-4 and 96-4 decreased from 0.17 – 0.09 mol m^{-2} s^{-1} with their stomatal resistance increasing from 6.49 – 11.62 m^2 s mol^{-1}. The minimum stomatal conductance and maximum stomatal resistance were observed in the genotype 96-4 while Sree Bhadra showed the maximum stomatal conductance and minimum stomatal resistance. Maximum rates of photosynthesis and transpiration were observed in Sree Bhadra and minimum in 96-4. High stomatal conductance might have contributed to the high

photosynthetic and transpiration rates in Sree Bhadra, while low photosynthetic and transpiration rates observed in 96-4 may be due to low stomatal conductance and high stomatal resistance. Kubota *et al.* [9] have considered stomatal resistance as an important factor influencing photosynthesis in sweet potato leaves, as it regulates CO_2 concentration. Ravi [6] has also supported this contention, and observed that an increase in stomatal resistance decreases the stomatal conductance, leading to a reduction in transpiration and photosynthetic rates.

The genotypes Sree Bhadra, Sree Rethna, KV – 4, 91 – 7 and 96 – 4 with increased stomatal resistance showed decreased stomatal conductance while the genotypes 96 – 4, 95 – 1, A – 144, 94 – 57 and Sree Bhadra, with decreased stomatal resistance exhibited increase in stomatal conductance (Table 1).

The genotypes 94 – 57, Sree Rethna and Sree Bhadra with a high stomatal conductance showed comparatively high photosynthetic and transpiration rates. The genotypes KV-4, 95-1, 94-86, Kanjangad local, A-144 and 91-7 with medium stomatal conductance had medium photosynthetic and transpiration rates. The genotype 96-4 with low stomatal conductance had low rates of photosynthesis and transpiration. Morphological analysis in the present study had shown that the genotypes 94-57, Sree Rethna and Sree Bhadra are high yielding varieties, KV-4, 94-86, Kanjangad local and A-144 medium yielding and 96-4 low yielding. These morphological observations are in tune with the results obtained here, and hence it may be inferred that differences in photosynthetic and transpiratory rates have a major role to play in the differences in storage root yield.

CONCLUSIONS

The stomatal conductance (g_s) and stomatal resistance (r_s) were found to be varied among the genotypes. Decrease in stomatal conductance and increase in stomatal resistance was noticed at a time in all the genotypes. High photosynthetic rate and transpiration rate was obtained in Sree-Bhadra was due to high stomatal conductance. Low photosynthetic rate and transpiration rate was obtained in 96-4 was due to low stomatal conductance and high stomatal resistance. Photosynthetic rate and transpiration rate was found to be varied among the genotypes. An increase in stomatal conductance increases transpiration rate and photosynthetic rate in the sweet potato genotypes. The differences in photosynthetic rate and transpiration rate attributed to the difference in storage root yield.

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